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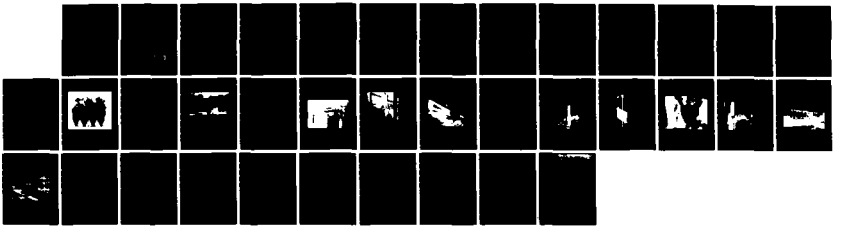

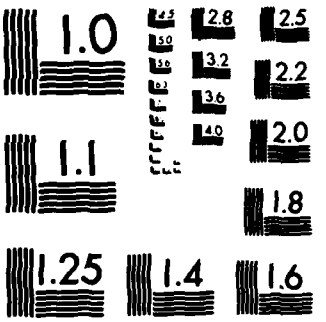

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DNA 6518H

THERMAL RADIATION SOURCE TEST FACILITY

Field Command Test Directorate
Defense Nuclear Agency
Kirtland AFB, New Mexico 87115

1 January 1984

Handbook

Prepared for
Director
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1. REPORT NUMBER DNA 6518H	2. GOVT ACCESSION NO. AD-A140561	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Thermal Radiation Source Test Facility ~~Kirtland Air Force Base, New Mexico~~		5. TYPE OF REPORT & PERIOD COVERED Handbook 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) William F. Taylor, LCDR, USN		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Field Command Test Directorate Defense Nuclear Agency Kirtland AFB, New Mexico 87115		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Director Defense Nuclear Agency Washington, D.C. 20305		12. REPORT DATE 1 January 1984 13. NUMBER OF PAGES 32
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Thermal Radiation Source
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the Thermal Radiation Source (TRS) Test Facility at Kirtland AF Base, New Mexico. It lists the instrumentation and equipment available for use by DOD and other government agencies studying the effects produced by nuclear weapons.

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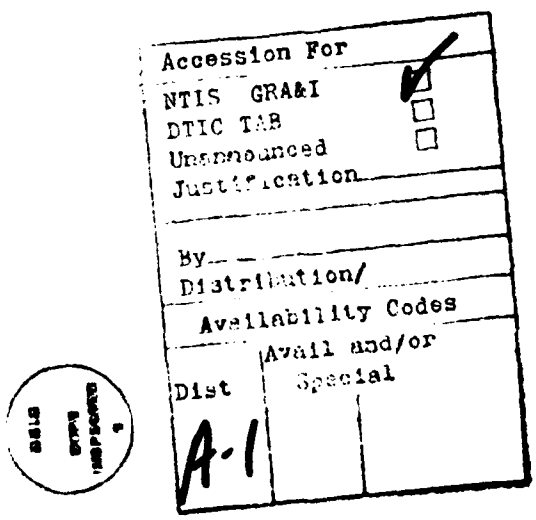
PREFACE

This report describes the Thermal Radiation Source (TRS) Test Facilities at Kirtland Air Force Base, New Mexico. It gives the output spectrum, and the rise and decay times of the output pulse. This report lists the instrumentation available for use by DOD and other government agencies and delineates the user responsibilities.



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INTRODUCTION

1-1 GENERAL

Defense Nuclear Agency's Field Command, located at Kirtland AFB in New Mexico, has recently upgraded its thermal test facility which is used to simulate the intense heat emitted by the fireball from a nuclear weapon explosion. Field Command operates the Thermal Radiation Source (TRS) as a service to DOD and other government agencies studying the heat effects produced by nuclear weapons. Test objects such as aircraft airframe component, communications equipment, and samples of advanced materials are subjected to the searing radiant heat produced by the thermal source.

The improved facility can accommodate test objects up to 30 feet long and includes a computerized data acquisition system for recording 400 separate measurements simultaneously. Three hundred and twenty megawatts of heat are produced by a four-nozzle flame thrower-like device which burns a flowing mixture of liquid oxygen and powdered aluminum. In a vertical orientation of the nozzles it produces a wall of flame 30 feet wide and 20 feet high burning at 4700 degrees Fahrenheit. The heat is sufficient to melt aluminum and to cause test objects to burst into flame. The data gathered is used to evaluate damage and survivability in a nuclear environment.

The thermal test facility was first established in 1979 and used large exploding bags of oxygen gas and powered aluminum to produce heat. Preparation of the bags was a slow process requiring several days between tests. Since that time FCDNA has improved the device by replacing the bags with nozzles which require only 1½ hours preparation between tests. The heat output of the nozzles is also adjustable by varying the length of operation, which is a few seconds for a typical test. The new simulator is less expensive to operate and can accommodate a greater variety of test requirements.

Table 1 gives a summary of the facts and capabilities of the KAFB TRS facility.

1-2 PURPOSE

The Thermal Radiation Source simulates the radiant heat emitted by the fireball from a nuclear weapon. The TRS is unique among presently available thermal simulators (e.g., lamps and solar facilities) in that large test objects -

Table 1. Thermal Radiation Source Facility (TRS).

Facts and Capabilities

GENERAL

Site Size	- 7 Acres
Site Completion Date	- October 1982
Site Cost	- $300,000.00
Site Altitude	- 5,800 feet
Security	- Planned 8 foot chain link fence
Support & Administration	- 320 Sq Ft office space available - One Class "A" telephone line - 640 Sq Ft out of weather storage
Test Bed	- Outdoor - 8,000 Sq Ft (paved by June 1984)
Data Acquisition	- 400 channels available - 12 movable asymptotic calorimeters - 1 mv to 100 mv signals can be processed (w/o conditioning.) - PDP 11/24 computer used for processing - Data can be plotted in either Raw Engineering Units or Voltage (calibrated).

TECHNICAL

Operation

- 4 upward directed nozzles
- Flowing liquid oxygen and aluminum powder flame at each nozzle
- Flow rates per nozzle:
  - LOX 5 liters/sec
  - AL 5 Kg/sec
- Variable spacing of nozzles up to 10 feet separation

Output

- 70 $Cal/Cm^2/sec$
- 3000 degrees K
- .75 second risetime
- Pulse duration adjustable up to 5 seconds in length
- 60 megawatts of radiant heat produced at each nozzle

TRS RECENT TEST HISTORY

US ARMY TACTICAL TIRES	DECEMBER 1982
BOEING MILITARY AIRCRAFT CO.	JANUARY 1983
B1-B COMPONENTS	APRIL 1983

up to 30 feet long by 12 feet high - can be accommodated. The TRS test facility is operated by DNA for use by government agencies and their contractors who are involved in nuclear weapons effects testing.

SECTION 2

KIRTLAND AF BASE TRS FACILITY

2.1 OVERVIEW

The Thermal Radiation Source (TRS) facility is located 8 miles south of the Kirtland Air Force main base on 7 acres. The test pad area is 8000 ft^2; a telephone, 110 V ac power, and limited office and storage facilities are available. Figure 1 is a sketch of the test facility layout. The normal military base security; housing and eating facilities are available on Kirtland and in Albuquerque.

2.2 OUTPUT

A flux of up to 70 $cal/cm^2/s$ can be delivered by the TRS to a test object. The emission spectrum of the TRS is very similar to that of a black body at a temperature of 2800 K (Figure 2). Consequently the TRS is limited as a simulator by being somewhat cooler (emitting at longer wavelengths) than a nuclear fireball (6000 K). The thermal output pulse of the TRS approximates a square-wave with a 0.75-second rise time and a similar decay time. Each nozzle produces 60 megawatts of radiant heat. The pulse duration is adjustable up to about 5 seconds in length. Figure 3 shows a four-nozzle burn.

2.3 INSTRUMENTATION

The TRS test facility includes 2 weather stations with readout of wind, temperature, pressure, and pressure trend for monitoring wind conditions, 12 movable asymptotic calorimeters for measuring thermal flux, and a 400-channel data acquisition system for user-installed instrumentation. Twelve oscilloscopes with cameras are also available for recording data. Up to 400 signals can be amplified, converted from analog to digital, and multiplexed into 3 channels. Of these, 200 channels can be conditioned for use with bridge-type gages that require excitation voltages. Signal amplitudes from 1 mV to 100 mV can be processed without conditioning. The digital sampling rate is 118 per second with a 10-bit amplitude resolution. An automatic calibration sequence inserts a series of known voltages into the amplifiers. The multiplexed data is recorded in duplicate on two 14-track analog magnetic tape recorders. Data can be plotted in either raw, engineering units or voltage (calibrated).

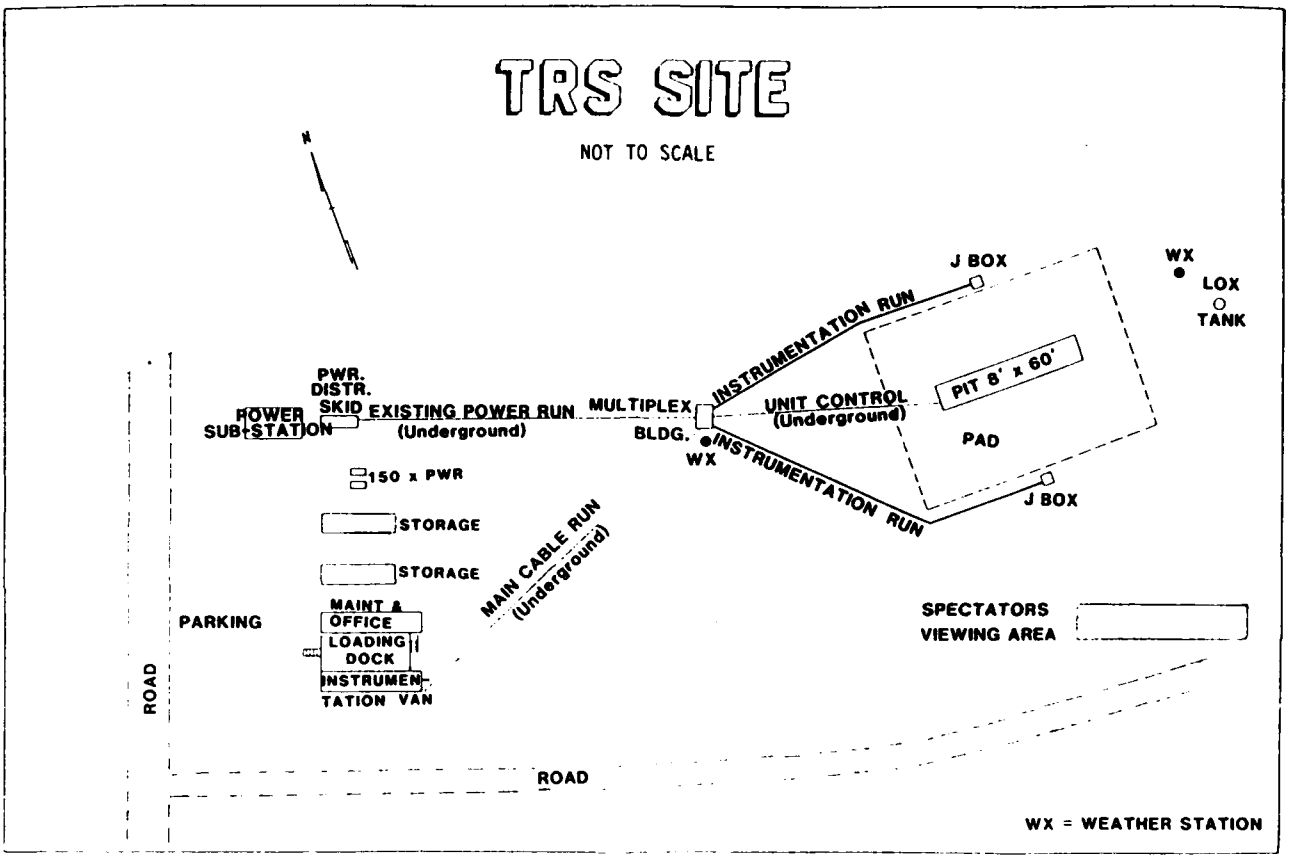

Figure 1. TRS site layout.

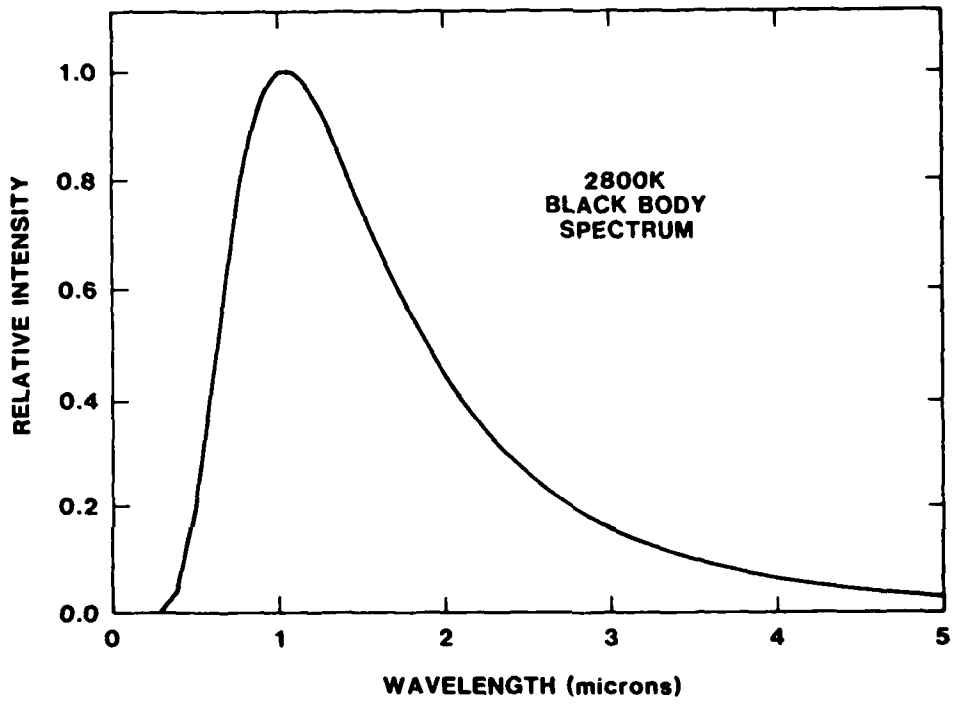

Figure 2. 2800K black body spectrum.

Figure 3. Four-nozzle burn.

The user is provided the magnetic tape and the plots as desired. Two identical video taping systems, complete with diagnostic timing, are available at the TRS site. Figure 4 is a view of the equipment and administrative trailers.

2.4 EQUIPMENT

Table 2 lists the various recorders, oscilloscopes, cameras, etc., available at the Kirtland facility.

2.5 OPERATIONS

The TRS operates on an outdoor test bed and consists of a linear array of four upward-directed nozzles each of which produces a flame 2 meters in diameter and 6 meters high. Heat is produced by the chemical reaction between flowing liquid oxygen and aluminum powder. Flow rates are 5 liter/s and 5 kg/s for LOX and aluminum, respectively, per nozzle. The nozzles are moveable such that the spacing between them can be varied from 3 feet up to 10 feet. Figures 5 and 6 show the LOX tanks and the underground plumbing for the system. Figure 7 shows the aluminum powder being put into the system.

Figure 4. Equipment and administrative trailers.

Table 2. Equipment at the Kirtland AFB TRS facility.

Sony Model DXC-1610 Color Video Cameras	2 ea.
VTG-33 Video Timers	2 ea.
JVC Mod CR-6060/U Video Recorder	1 ea.
Sony UMHTIC S Video Recorder	1 ea.
Mod R-454A Tektronix Oscilloscopes	12 ea.
C-32 Synchro Electronics Cameras	12 ea.
C-30 Series Camera Roll Film Backs	12 ea.
Sangamo 4700 14-track recorders	2 ea.
SAI Digital Multiplex Units (Total of 400 channel capability)	3 ea.
Aydin PCM Bit Sychronizer	1 ea.
Aydin PCM Frame Sychronizer	1 ea.
TU-10 9-channel Digital Tape Records	2 ea.
PDP 11/24 Digital Computer (a -124K Memory)	1 ea.
Mod DSD 440 120 Disc Drive Unit	1 ea.
Heath/Zenith Digital Weather Computers	2 ea.
Motorola Maxar UHF Base Station	1 ea.
Motorola HT220 Field Radios	10 ea.
Tektronix 4006-1 Terminal Unit	1 ea.
Versatic Copier	1 ea.
Hewelett/Packard 3603A Tape Degausser	1 ea.
CEC Type 1-184 Zero Suppression Amplifier	14 ea.
Medtherm Mod 64-250-14 Calorimeters	45 ea.
Assorted Test Equipment to Maintain Electronics Equipment.	

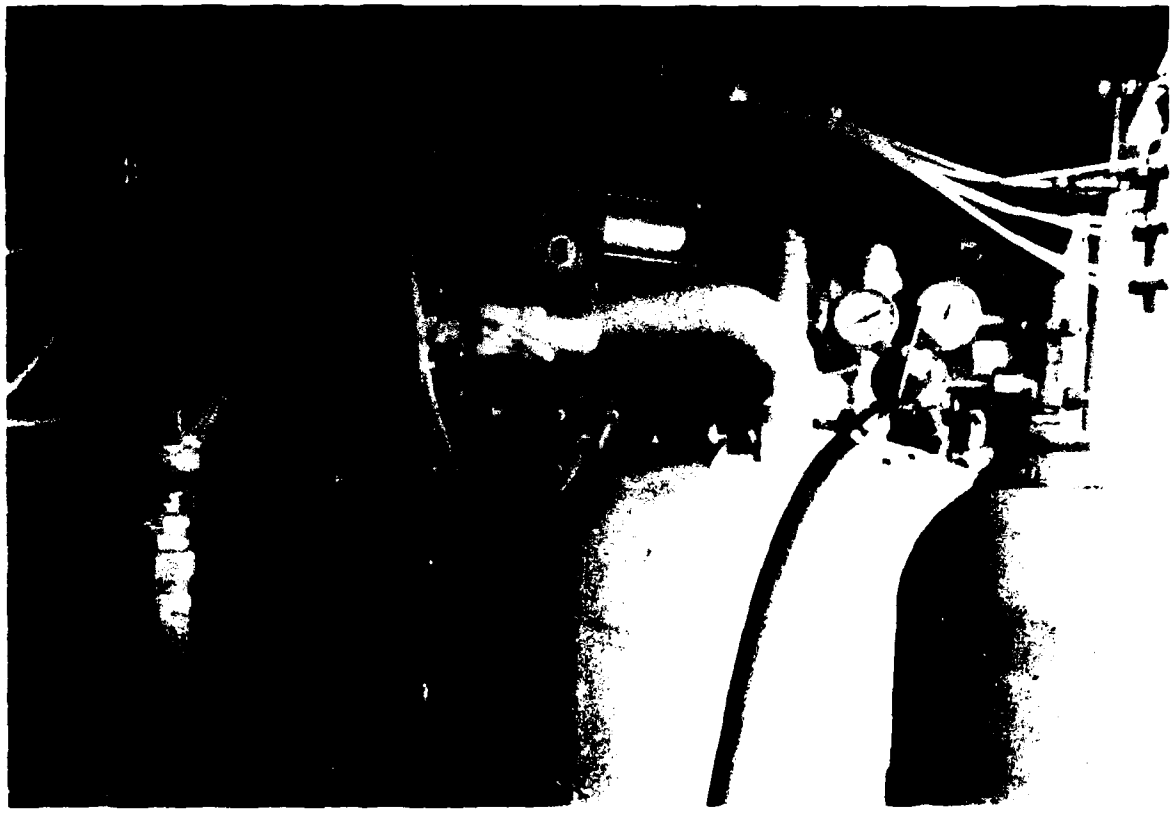

Figure 5. Unit LOX tank.

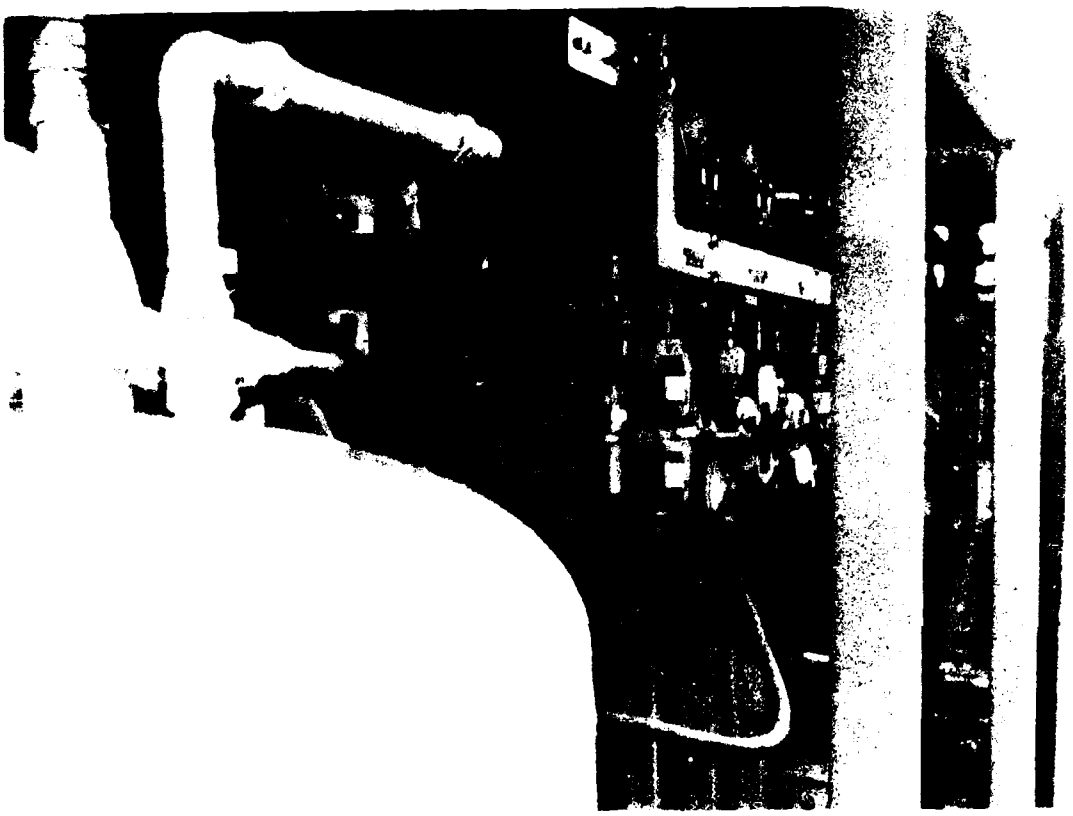

Figure 6. Connection to the N_2 tanks.

Figure 7. Pouring aluminum powder (loading unit).

SECTION 3

FACILITY UTILIZATION

3.1 TESTING

The TRS can be fired several times a day with a turnaround time of 1½ hours between shots. Since the TRS is located outdoors, weather is a consideration in planning tests. It is generally desireable to conduct tests when winds are below 8 mi/h. The TRS thermal output has a nominal variability of ± 10% from shot to shot under calm winds. Figures 8, 9, and 10 show 2 different types of targets. Figure 11 shows the typical calorimeter setup used on the test site.

Several portable TRS have been used in conjunction with large DNA high explosive test at White Sands Missile Range, NM.

A portable version of the Thermal Radiation Source (Figures 12 and 13) was taken to the White Sands Missile Range for use on a DNA-sponsored high explosive test scheduled for September 1981. The MILL RACE event involved 5 separate thermal sources which were fired simultaneously along with a charge of 600 tons of conventional explosives. With this combination the synergistic effects of heat and blast from a nuclear explosion was simulated and studied. The test was highly successful and resulted in DNA experiencing an increased demand from DOD agencies for combined thermal and blast testing of military equipment.

3.2 RESPONSIBILITIES

FCDNA provides the following: personnel to operate the TRS and the data acquisition system, a limited number of calorimeters (about 12) to measure the flux field on each test, a limited amount of video recording and documentary photography. The user provides the following: test samples, gages, labor and material to install gages and connect them to field junction boxes, and technical photography. User costs are worked out between FCDNA and the user. For more information contact personnel at the TRS Facility: Phone 505-846-6305 or write Commander, Field Command, DNA, Attn: FCTOS, Kirtland Air Force Base, New Mexico 87115.

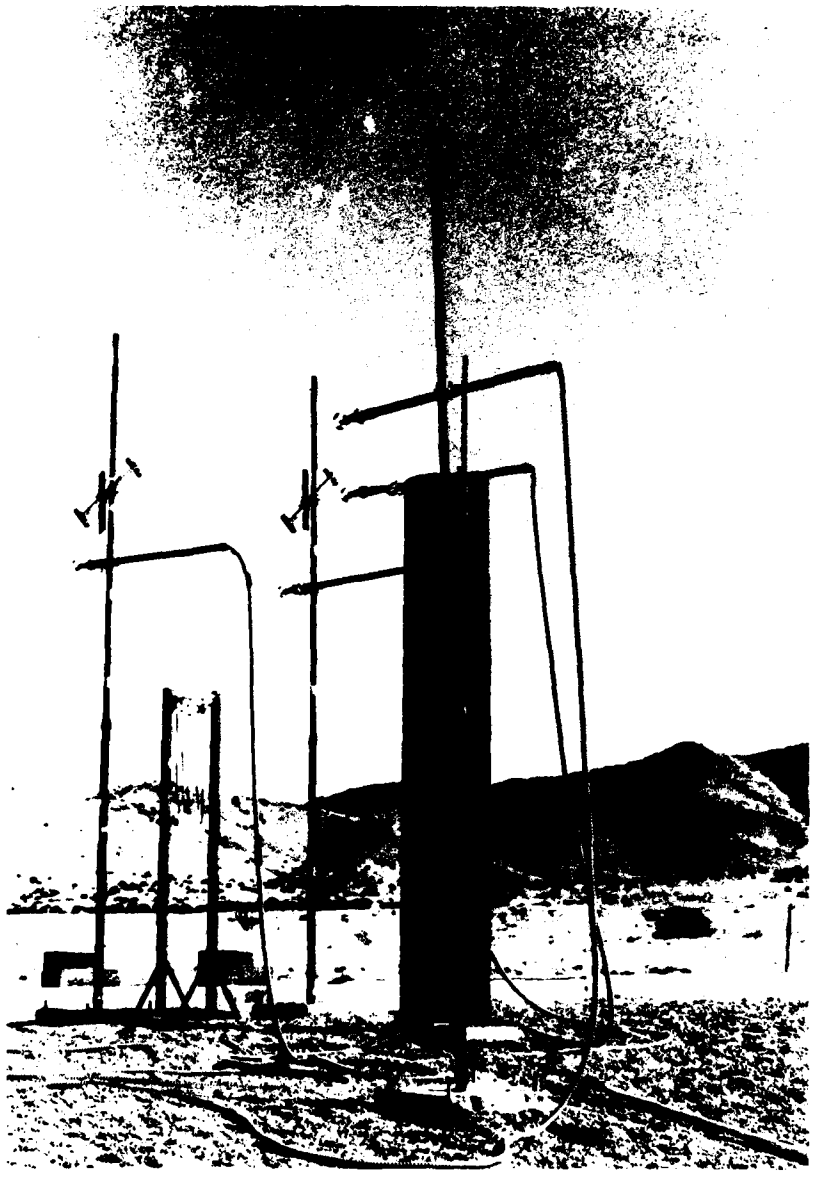

Figure 8. Target at TRS site.

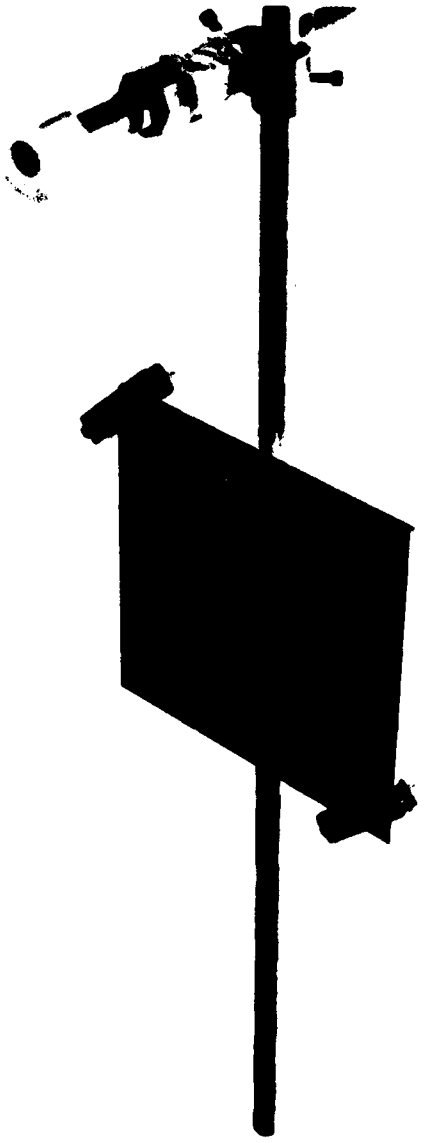

Figure 9. Target and calorimeter.

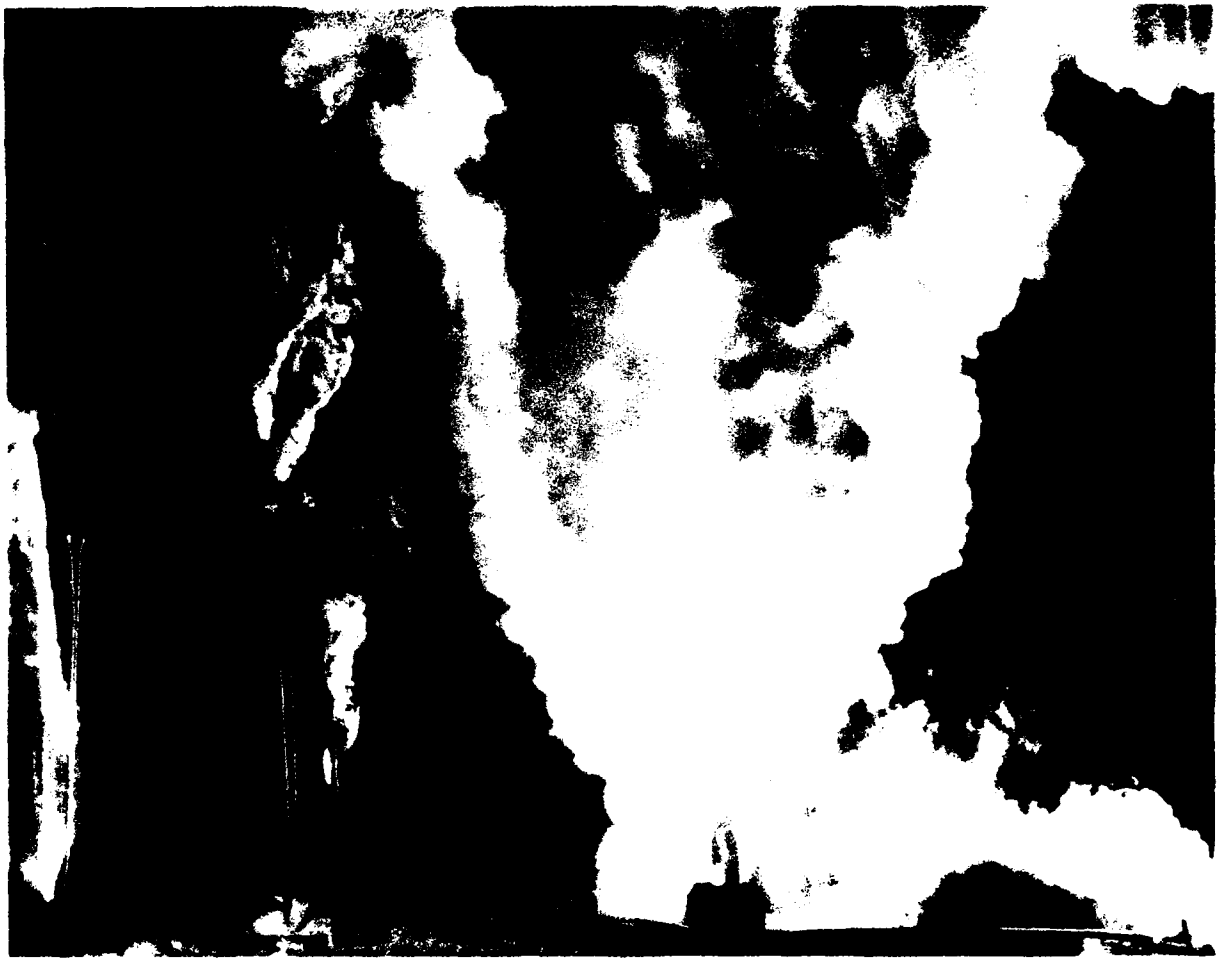

Figure 10. End-on view of TRS in operation. Test objects on left side of photo are smoking and bending from exposure to intense heat.

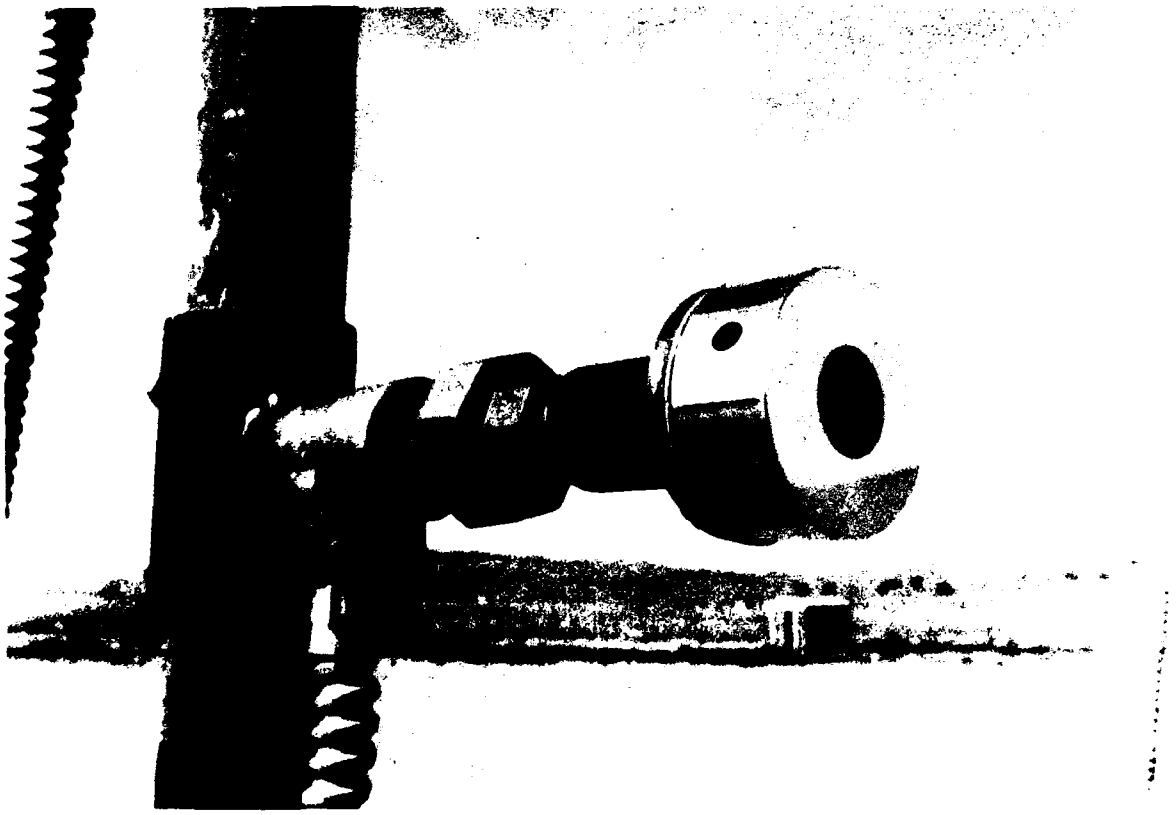

Figure 11. Calorimeter.

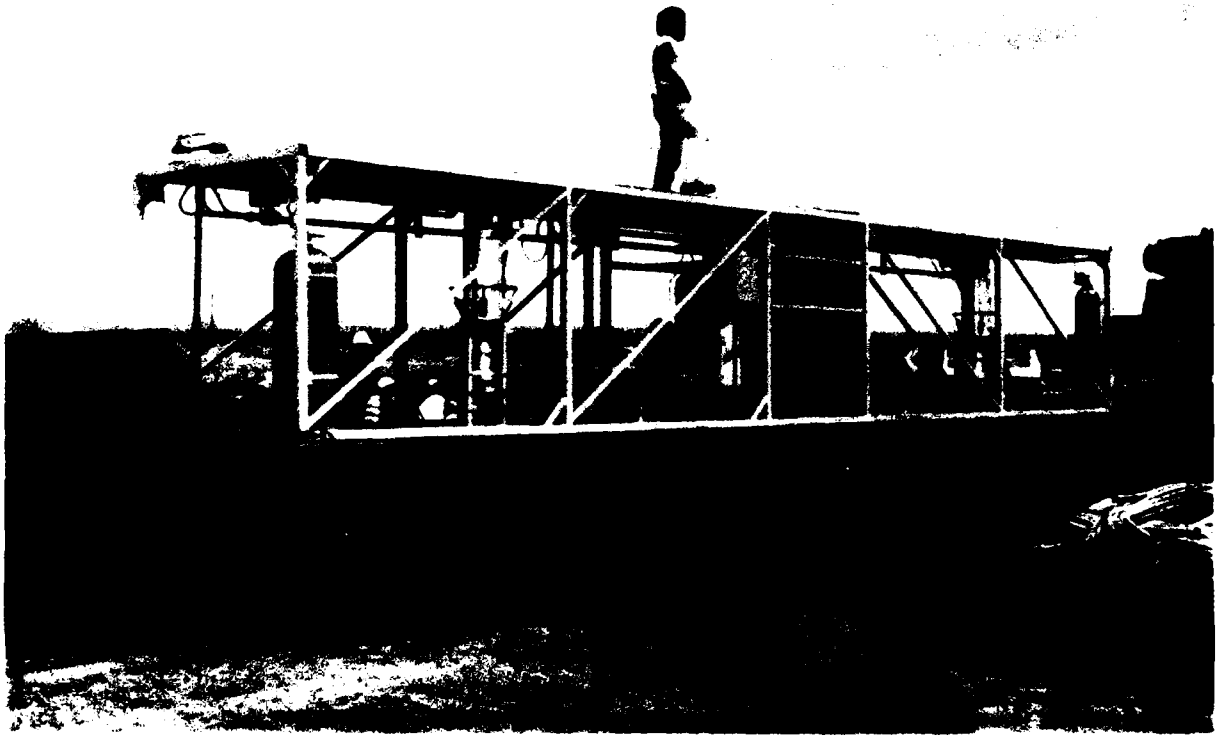

Figure 12. TRS system (above ground).

Figure 13. TRS system (below ground).

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USER EVALUATION OF THERMAL RADIATION SOURCE TEST FACILITY REPORT

Please take a few minutes to answer the questions below; tear out this sheet, fold as indicated, staple or tape closed, and place in the mail. Your comments will provide us with information for improving future reports.

1. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which report will be used.)

_____

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2. How, specifically, is the report being used? (Information source, design data or procedure, management procedure, source of ideas, etc.)_____

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3. Has the information in this report led to any quantitative savings as far as man-hours/contract dollars saved, operating costs avoided, efficiencies achieved, etc.? If so, please elaborate.

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4. General Comments (Indicate what you think should be changed to make this report and future reports of this type more responsive to your needs, more usable, improve readability, etc.)_____

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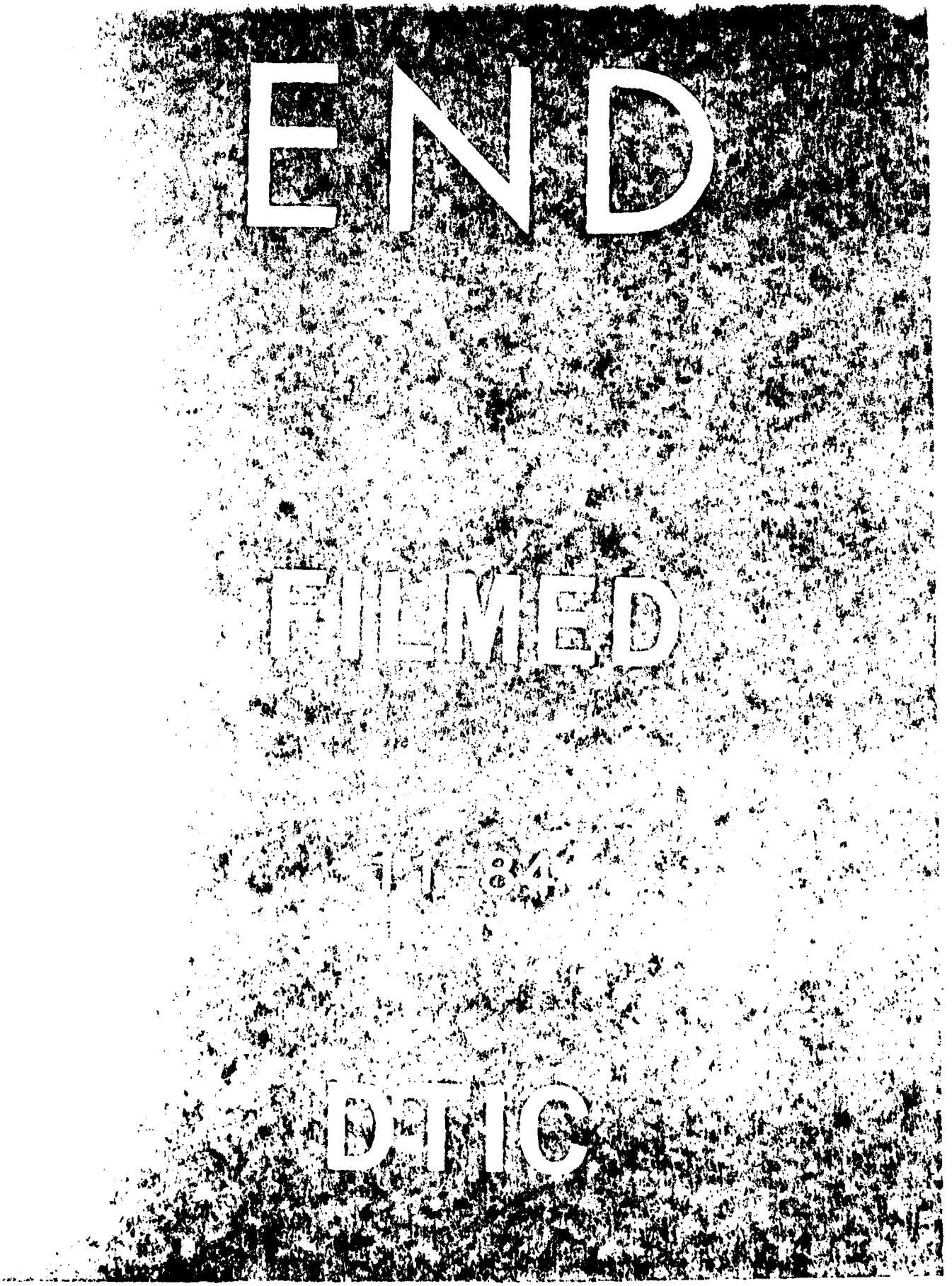
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